



## **Safety Function: Door Monitoring**

Products: Trojan 5 Interlock Switch, Guardmaster Safety Relay,  
PowerFlex 525 Drive with Safe Torque-off  
Safety Rating: CAT. 3 PLd to EN ISO 13849-1: 2008

LISTEN.  
THINK.  
SOLVE.®

## Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.






In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	<b>WARNING:</b> Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	<b>ATTENTION:</b> Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
<b>IMPORTANT</b>	Identifies information that is critical for successful application and understanding of the product.
Labels may also be on or inside the equipment to provide specific precautions.	
	<b>SHOCK HAZARD:</b> Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	<b>BURN HAZARD:</b> Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	<b>ARC FLASH HAZARD:</b> Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

## General Safety Information

Contact Rockwell Automation to find out more about our safety risk assessment services.

<b>IMPORTANT</b>	This application example is for advanced users and assumes that you are trained and experienced in safety system requirements.
	<b>ATTENTION:</b> Perform a risk assessment to make sure all task and hazard combinations have been identified and addressed. The risk assessment can require additional circuitry to reduce the risk to a tolerable level. Safety circuits must take into consideration safety distance calculations, which are not part of the scope of this document.

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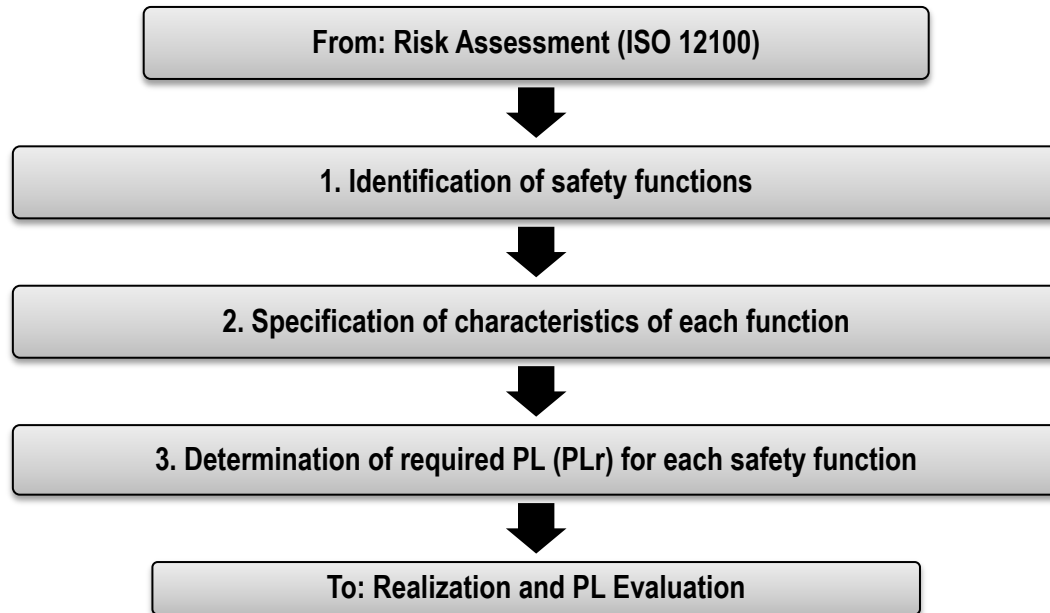
## Introduction

This safety function application technique explains how to wire, configure, verify, and validate a safety system where a Guardmaster® dual-input safety relay (GSR DI) monitors an E-stop and a Trojan® 5 tongue switch mounted on a gate. If the E-stop is pressed, the gate is opened, or a fault is detected in the monitoring circuit, the GSR DI de-energizes the final control devices, in this case, the PowerFlex® 525 drive via its two safe torque-off (STO) inputs.

This example uses a GSR DI safety relay, but the concept is applicable to any suitable safety relay. This example uses an E-stop and a Trojan 5 tongue switch, but the concept is applicable to any dual-channel electro-mechanical device with at least two N.C. contacts. The SISTEMA calculations shown later in this document must be re-calculated by using data for the actual products used.

## Safety Function Realization: Risk Assessment

The required performance level is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the performance level required (PLr) by the risk assessment is Category 3, Performance Level d (CAT. 3, PLd), for each safety function. A safety system that achieves CAT. 3, PLd, or higher, can be considered control reliable. Each safety product has its own rating and can be combined to create a safety function that meets or exceeds the PLr.



## Door Monitoring Safety Function

Part of the risk reduction process is to determine the safety functions included in the safety project. This safety project has two safety functions:

- Removal of power from the motor when the E-stop is pressed
- Removal of power from the motor when the gate is opened

## Safety Function Requirements

Pressing the E-stop or opening the guard gate stops hazardous motion by removal of power to the motor. When the E-stop is released and the guard gate is closed, power to the motor and hazardous motion does not resume until the safety system is reset and a secondary action (Start button is pressed and released) occurs. Faults at the E-stop, gate interlock switch, wiring terminals, or safety controller are detected before the next safety demand.

The PowerFlex 525 drive monitors itself for input, internal, and output faults. When the PowerFlex 525 drive detects a fault, it turns off its output, removing power to the motor. The fault must be corrected and power to the drive cycled before the drive can be restarted. Faults at the safe torque-off (STO) inputs on the PowerFlex 525 drive can go undetected.

The safety functions in this application technique each meet or exceed the requirements for Category 3, Performance Level d (CAT. 3, PLd), per EN ISO 13849-1 and control reliable operation per ANSI B11.19.

## Functional Safety Description

Hazardous motion is stopped by pressing the E-stop button or opening the guard gate. Hazardous motion cannot be resumed until the E-stop is released, the guard gate closed, and the Guardmaster dual-input safety relay (GSR DI) reset.

The N.C. contacts of the E-stop are connected between the GSR DI S11 and S21 pulse test outputs of the GSR DI and the IN1 terminals S12 and S22 of the GSR DI. The N.C. contacts of the Trojan 5 switch are connected between the S11 and S21 pulsed outputs of the GSR DI and the IN2 terminals S32 and S42 of the GSR DI.

The N.O. safety outputs of the GSR DI are connected between the 24V DC supply and the safe torque-off (STO) inputs of the PowerFlex 525 drive.

When all of the safety inputs of the GSR DI are satisfied, no faults are detected, and the Reset button is pressed and released, the N.O. safety outputs close, providing 24V DC to the STO inputs. Pressing the PowerFlex 525 drive Start button provides power to the controlled motor and hazardous motion commences.

## Bill of Material

This application uses these products.

Cat. No.	Description	Quantity
440K-T11090	Tongue switch - Trojan 5: contacts (safety and aux): 2 N.C., 1 N.O., BBM preference: break before make, actuator: standard, model type: standard, conduit entry: M20 conduit	1
800F-1YP8	800F 1-hole enclosure E-stop station, plastic, pg, twist-to-release, 60 mm, non-illuminated, 2 N.C. / 1 N.O.	1
440R-D22R2	Guardmaster dual input safety relay, 2 dual channel universal inputs, 2 N.O. safety outputs, 1 N.C. solid state auxiliary output	1
25B-B2P5N104	PowerFlex 525 AC drive, with embedded EtherNet/IP and safety, 240V AC, 3 phase, 0.5 HP, 0.4 kW normal duty; 0.5 HP, 0.4 kW heavy duty, frame A, IP20 NEMA / open type, no filter	1
800FP-U2E4F3PX11	800F 2 position momentary multifunction- rd. plastic (IP66, 4/4x, IP65), position A- red ext. push button, position C-green flush push button, plastic latch mount, 1 N.O. contact, 1 N.C. contact, standard, standard pack (quantity 1)	1
800FP-R611PX10	800F reset, round plastic (type 4/4x/13, IP66), blue, R, plastic latch mount, 1 N.O. contact, 0 N.C. contacts, standard, standard pack (quantity 1)	1

## Setup and Wiring

For detailed information on installation and wiring, refer to the publications listed in the [Additional Resources](#).

### System Overview

The Guardmaster dual-input safety relay (GSR DI) monitors the two N.C. channels of the E-stop. When the E-stop is pressed, these two channels open, and the GSR DI reacts by de-energizing its N.O. safety contacts, removing 24V DC from the drive safe torque-off (STO) inputs. The PowerFlex 525 drive turns off its outputs and the motor coasts to a stop.

The GSR DI monitors the two N.C. channels of the Trojan 5 switch. When the guard gate is opened, these two channels open, and the GSR DI reacts by de-energizing its N.O. safety contacts, removing 24V DC from the drive STO inputs. The PowerFlex 525 drive turns off its outputs and the motor coasts to a stop.

The GSR DI monitors each input channel for a contact failed open (loose wire), a contact failed closed, a channel short to 24V DC supply, a channel short to 24V COM, and channel-to-channel shorts. When such a fault occurs, the GSR DI de-energizes its N.O. safety contacts, removing 24V DC from the drive STO inputs. The PowerFlex 525 drive turns off its outputs and the motor coasts to a stop.

A single input channel fault, a contact failed open, or a contact failed closed, is considered a relatively minor fault, for example, a sticky contact. In the case of a single channel fault, a successful cycle of that input is where both channels open and close properly, the fault clears, and the subsequent pressing and releasing of the Reset button energizes the safety outputs, which allows a start/restart of the motor.

An input channel short fault is considered to be a major fault. An input channel short fault can be an input channel shorted to 24V DC, an input channel shorted to 0V DC, or input channels shorted together. When an input channel short fault is detected, the GSR DI de-energizes its outputs immediately, regardless of the state of the input devices. In the case of an input channel short fault, the GSR DI must first be powered down and the short found and removed. Then power is restored to the GSR DI to clear the fault. When the E-stop is not pressed and the gate is closed, subsequent pressing and releasing of the Reset button energizes the safety outputs, which allows a start/restart of the motor.

The PowerFlex 525 drive monitors the STO inputs. If one input channel applies power or removes power when the other channel does not, the PowerFlex 525 drive turns off its output and cannot be run until the fault is corrected. The PowerFlex 525 drive must be power-cycled and both STO inputs must be in the applied power state before the drive responds to the start/restart button.

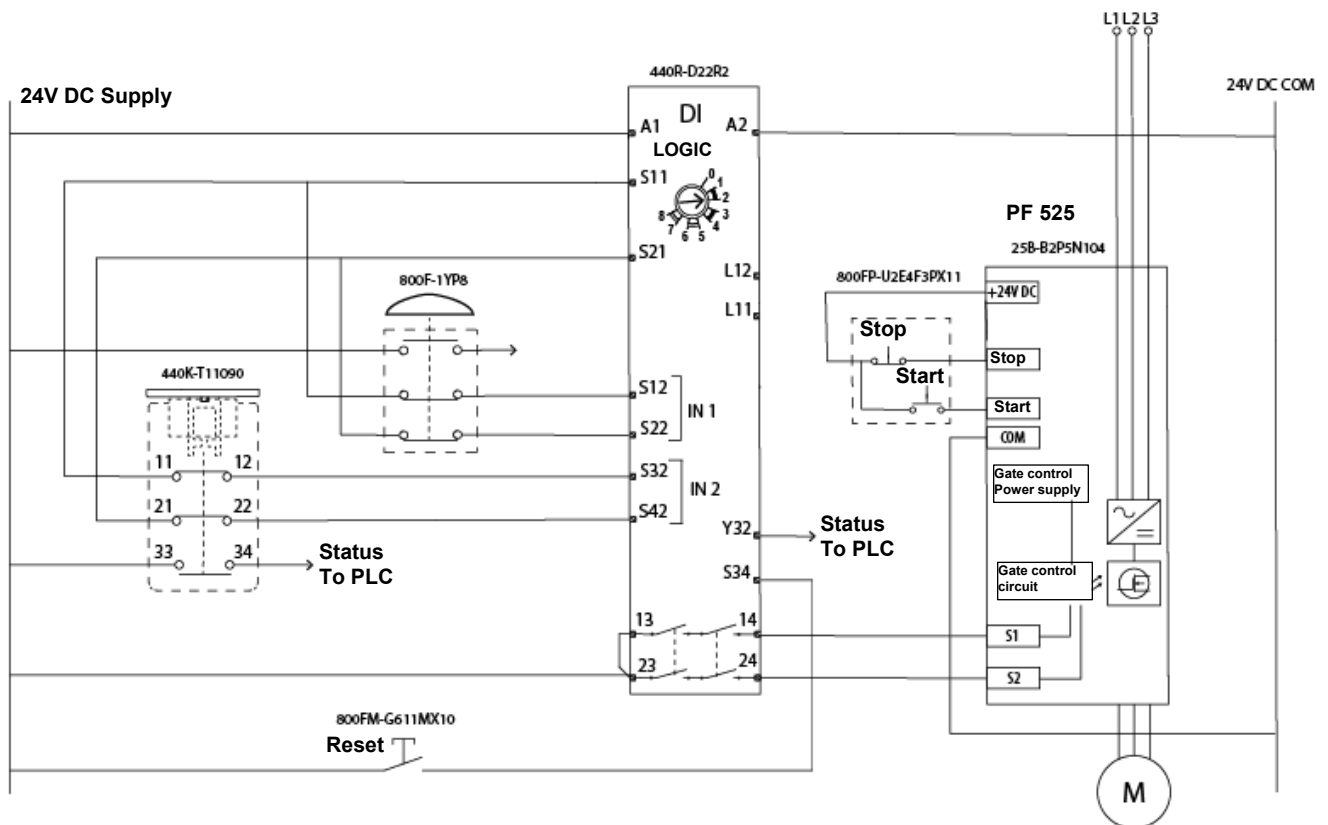
### Channel Operation and Verification

Safety Function Status	Drive In Safe State	Drive In Safe State	Drive In Safe State	Drive Able to Run
Drive Status	Configured by t105 [Safety Open En]	Fault F111 (Safety Hardware)	Fault F111 (Safety Hardware)	Ready/Run

### Safety Channel Operation

Safety Input S1	No Power Applied	Power Applied	No Power Applied	Power Applied
Safety Input S2	No Power Applied	No Power Applied	Power Applied	Power Applied

### Electrical Schematic



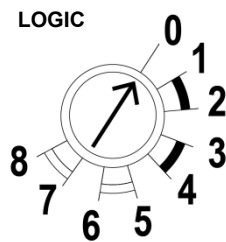
## Configuration

### Configure the Guardmaster Dual-input Safety Relay

The following procedure sets the function of the device.

1. To start configuration/overwrite: with the power off, turn the rotary switch to position 0.

Apply power to the unit. After the power-up test, the PWD status indicator blinks red.



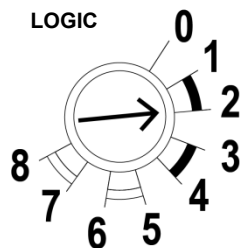
2. To set the configuration, turn the rotary switch to position 2.

The IN1 status indicator blinks for the new setting.

Position is set when the PWR status indicator is solid green.

3. Lock-in the configuration by cycling unit power.
4. Confirm the configuration before operation.
5. Record the unit setting in the white space on the face of the device.

**LOGIC 2 - L12 or (IN1 and IN2)**



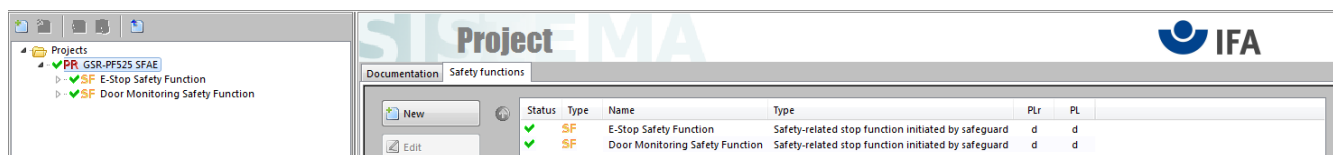
### About Configuring the PowerFlex 525 Drive

Configuration of the PowerFlex 525 drive is beyond the intended scope of this application technique. Other than configuring the drive to use the local Stop/Start button required by this application technique, the aspects of the drive configuration relative to performing its particular application tasks are not relevant to this application technique. Refer to the drive publications listed in the [Additional Resources](#) section for guidance in regard to installing and configuring the drive.

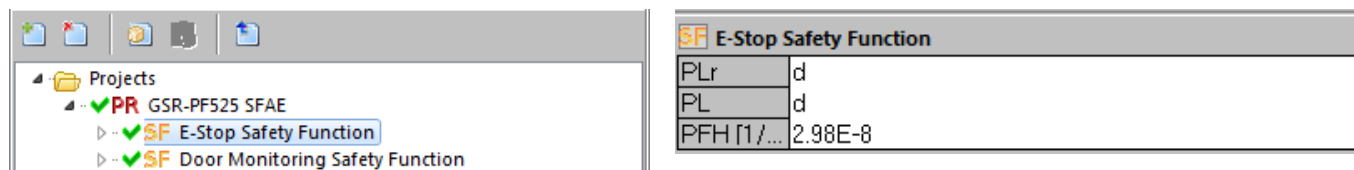


## Calculation of the Performance Level

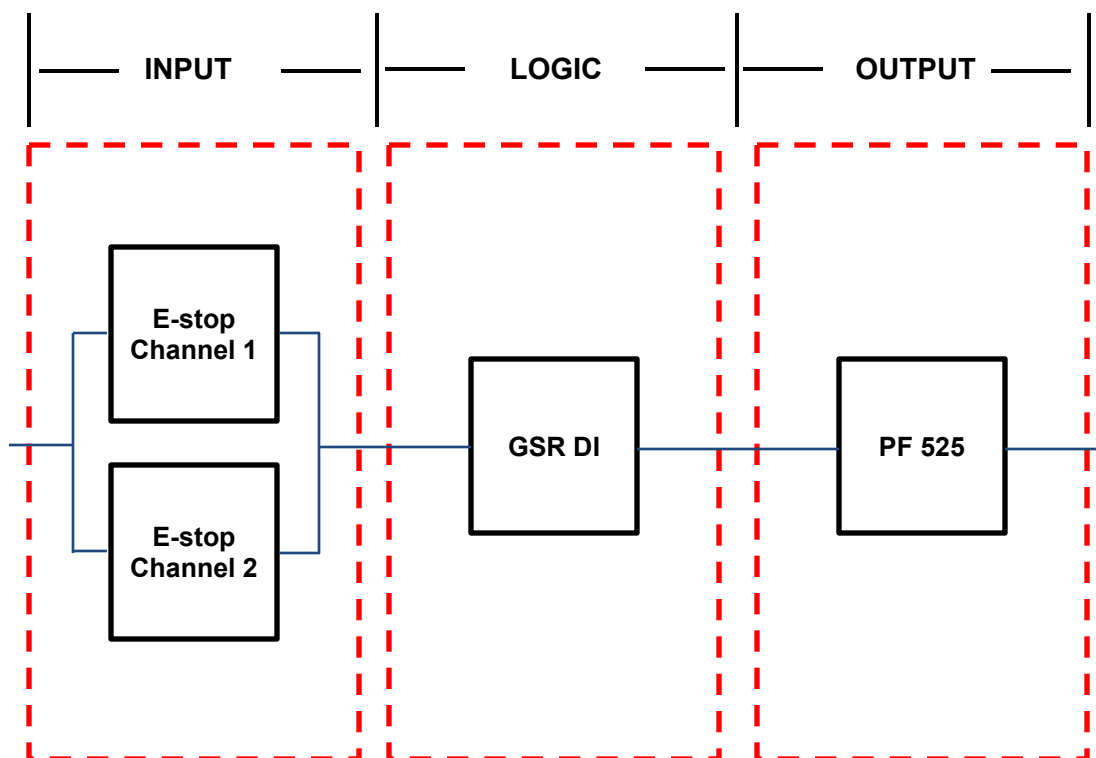
When properly implemented, these safety functions can achieve a safety rating of Category 3, Performance Level d (Cat. 3, PLd), according to EN ISO 13849-1: 2008, as calculated by using the SISTEMA software PL calculation tool.



### E-stop Safety Function



The E-stop safety function can be modeled as shown below.



Some of the data used in the SISTEMA software calculations comes from the Rockwell Automation safety product library. Other data must be entered by the user. In the case of mechanical devices, as in this document, the user must enter the Common Cause Failure (CCF) score, the Diagnostic Coverage (DCavg), the expected number of operations per year, and the category achieved by the specific circuit structure employed. The CCF score is derived by accumulating points based on good design practices and experience. Annex F of ISO 13849-1 covers this scoring process. A minimum score of 65 is required to avoid a penalty in the performance level calculation. Mechanical devices, such as the E-stop and the Trojan switch, have no diagnostic coverage of their own. The DCavg in this example is provided by the Guardmaster dual-input safety relay (GSR DI) with its pulse testing technique. This DCavg average is 99% as shown in the GSR DI Installation Instructions. See the [Additional Resources](#) on page 22.

EN ISO 13849-1		IEC 61508/IEC 62061	
PL	e	SIL	3
MTTFd[a]	355	PFH [1/h]	$4/35 \times 10^{-9}$
Cat.	4	HFT	1
DC avg.	99%	DC	99%

The E-stop safety function subsystem values are shown below.

The screenshot shows the SISTEMA software interface. The 'Safety function' window is open, displaying a table of subsystem values. The table has columns for Status, Type, Name, PL, PFH [1/h], CCF score, DCavg [%], MTTFd [a], Category, and Requirements of the category. The data is as follows:

Status	Type	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the category
✓	SB	E-Stop	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	4	fulfilled
✓	SB	Monitoring Safety Relay: GSR-DI	e	4.35E-9	not relevant	not relevant	not relevant	4	fulfilled
✓	SB	AC Drive: PowerFlex 525 with SafeTorque Off	d	8.13E-10	not relevant	not relevant	not relevant	3	fulfilled

The E-stop is a mechanical device and, as such, the expected number of times it is operated each year is used in the calculation of its Mean Time to Failure, dangerous (MTTFd). Calculations are based on the safety function being operated once an hour, 24 hours a day, 365 days a year for a total of 8760 operations per year.

SB E-Stop	
PL	e
PFH [1/...	2.47E-8
Cat.	4
MTTFd ...	100 (High)
DCavg ...	99 (High)
CCF	65 (fulfilled)

The GSR DI is more of an electronic device and, as such, is assumed to have an extremely long MTTFd. Therefore, the expected number of operations each year is not part of the calculation of its Performance Level.

SB Monitoring Safety Relay: GSR-DI	
PL	e
PFH [1/...	4.35E-9
Cat.	4
MTTFd ...	not relevant
DCavg ...	not relevant
CCF	not relevant

Likewise, the PowerFlex 525 drive is regarded as an electronic device. Therefore, the expected number of operations each year is not part of the calculation of its Performance Level.

SB AC Drive: PowerFlex 525 with SafeTorque Off	
PL	d
PFH [1/...	8.13E-10
Cat.	3
MTTFd ...	<i>not relevant</i>
DCavg ...	<i>not relevant</i>
CCF	<i>not relevant</i>

While the PowerFlex 525 drive has an excellent probability of failure per hour (PFH), it achieves a Category 3, Performance Level d (CAT. 3, PLd) due largely to its DCavg of 62.5%.

#### PFD and PFH for 20-year Proof Test Interval

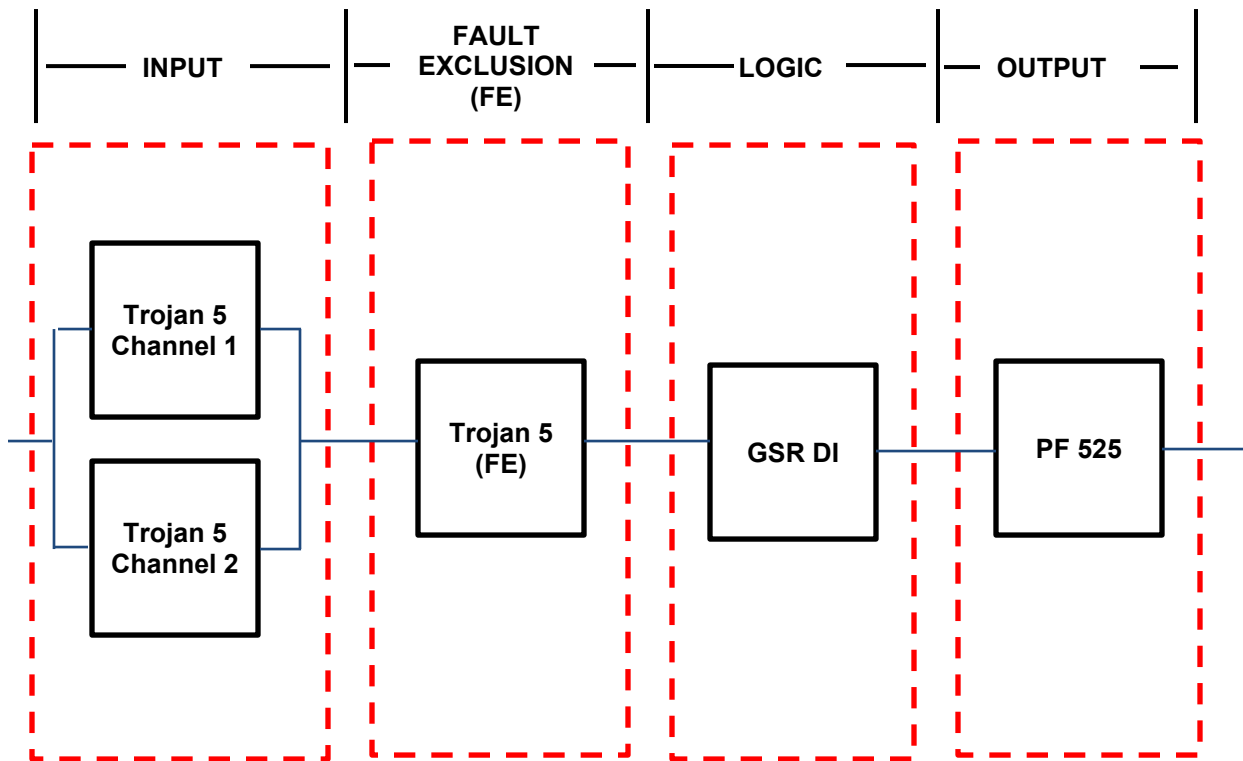
Attribute	Value
PFD	6.62E-05 (MTTF = 3593 years)
PFH <sub>D</sub>	8.13E-10
SFF	83%
DC	62.5%
CAT	3
HFT	1 (1oo2)
PTI	20 Years
Hardware Type	Type A

The attribute values above include both ISO 13849-1 and IEC 62061 values. The two standards are closely related. We refer to ISO 13849-1 values and calculations in this document.

#### Door Monitoring Safety Function

SF Door Monitoring Safety Function	
PLr	d
PL	d
PFH [1/...	3.46E-7

The door monitoring safety function can be modeled as shown below.



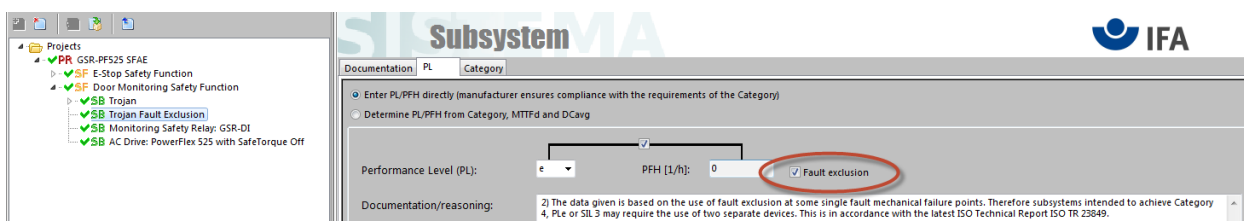
The door monitoring safety function subsystem values are shown below.

Safety function										
IFA										
Subsystems										
Library	Status	Type	Name	PL	PFH [1/h]	CCF score	DCavg [%]	MTTFd [a]	Category	Requirements of the category
Trojan	✓	SB	Trojan	e	2.47E-8	65 (fulfilled)	99 (High)	100 (High)	3	fulfilled
Trojan Fault Exclusion	✓	SB	Trojan Fault Exclusion	e	0	not relevant	not relevant	not relevant	3	fulfilled
Monitoring Safety Relay: GSR-DI	✓	SB	Monitoring Safety Relay: GSR-DI	e	4.35E-9	not relevant	not relevant	not relevant	4	fulfilled
AC Drive: PowerFlex 525 with SafeTorque Off	✓	SB	AC Drive: PowerFlex 525 with SafeTorque Off	d	8.13E-10	not relevant	not relevant	not relevant	3	fulfilled

The Trojan 5 switch is a mechanical device, therefore, the expected number of times it is operated each year is used in the calculation of its MTTFd. In this application technique, it is expected that the Trojan 5 switch is operated once an hour, 24 hours a day, 365 days a year for a total of 8760 times a year. The Trojan 5 switch can be used in either PLe or CAT. 4 systems. But, in general, to reach these ratings two Trojan switches would have to be used. Because the Performance Level required (PLr) of this project is CAT. 3, PLd, the more conservative single Trojan switch (CAT. 3) approach is appropriate. Because the Trojan 5 switch has the same MTTFd and DCavg as the E-stop, the SISTEMA calculation gives the Trojan 5 switch a PLe rating.

Trojan	
PL	e
PFH [1/...	2.47E-8
Cat.	3
MTTFd ...	100 (High)
DCavg ...	99 (High)
CCF	65 (fulfilled)

There is a possibility of failures related to the single actuation device of the Trojan 5 switch. This is addressed by including a Fault Exclusion subsystem.



The GSR DI values are the same as the E-stop safety function.

Monitoring Safety Relay: GSR-DI	
PL	e
PFH [1/...]	4.35E-9
Cat.	4
MTTFd ...	not relevant
DCavg ...	not relevant
CCF	not relevant

The PowerFlex 525 drive values are also the same as in the E-stop safety function.

AC Drive: PowerFlex 525 with SafeTorque Off	
PL	d
PFH [1/...]	8.13E-10
Cat.	3
MTTFd ...	not relevant
DCavg ...	not relevant
CCF	not relevant

## Verification and Validation Plan

Verification and validation play important roles in the avoidance of faults throughout the safety system design and development process. EN ISO 13849-2 sets the requirements for verification and validation. The standard calls for a documented plan to confirm all of the safety functional requirements have been met.

Verification is an analysis of the resulting safety control system. The Performance Level (PL) of the safety control system is calculated to confirm that the system meets the required Performance Level (PLr) specified. The SISTEMA software is typically used to perform the calculations and assist with satisfying the requirements of EN ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that the system meets the specified requirements of the safety function. The safety control system is tested to confirm that all of the safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions in addition to potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

*Prior to validating the Guardmaster Safety Relay (GSR) system, confirm that the Guardmaster safety relay has been wired and configured in accordance with the installation instructions.*

### Door Monitoring Safety Function Verification and Validation Checklist

General Machinery Information			
Machine Name/Model Number			
Machine Serial Number			
Customer Name			
Test Date			
Tester Name(s)			
Schematic Drawing Number			
Guardmaster Safety Relay Model	440R-D22R2		
PowerFlex Drive	25B-B2P5N104		
Safety Wiring and Relay Configuration Verification			
Test Step	Verification	Pass/Fail	Changes/Modifications
1	Visually inspect the safety relay circuit to verify that the safety relay circuit is wired as documented in the schematics.		
2	Visually inspect the safety relays' configuration switch settings to verify they are correct as documented.		
Normal Operation Verification - The safety system properly responds to all normal Start, Stop, Reset, E-stop, and Trojan switch inputs.			
Test Step	Verification	Pass/Fail	Changes/Modifications
1	Confirm that no one is in the guarded area.		
2	Confirm the E-stop is released.		
3	Confirm the gate is closed.		
4	Confirm the motor is stopped.		
5	Apply power to the safety system.		
6	Confirm that the motor does not start on powerup.		
7	Confirm that the PWR/Fault, IN1, and IN2 status indicators of the GSR DI are green.		
8	Confirm that the OUT status indicator of the blinks green.		
9	Press and release the Reset button. The OUT status indicator of the Guardmaster dual-input safety relay (GSR DI) turns steady green (ON). The motor does not start.		
10	Press the drive Start button to start the motor. The motor starts.		
11	Press the drive Stop button to stop the motor. The motor coasts to a stop. The safety relay does not trip.		
12	Press the Start button to start the motor.		

**Door Monitoring Safety Function Verification and Validation Checklist (continued)****Normal Operation Verification - The safety system properly responds to all normal Start, Stop, Reset, E-stop, and Trojan switch inputs. (continued)**

<b>Test Step</b>	<b>Verification</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
13	Press the E-stop button. The safety system trips and the IN1 and OUT status indicators turn OFF. The IN2 status indicator remains ON. The motor coasts to a stop. Do not release the E-stop button.		
14	Press and release the Reset button. The IN1 and OUT status indicators of the GSR DI remains OFF. The motor does not start.		
15	Release the E-stop button. The IN1 status indicator turns ON and the OUT status indicator blinks. The motor does not start.		
16	Press and release the Reset button. The OUT status indicator of the GSR DI turns steady green (ON). The motor does not start.		
17	Press the Start button to start the motor.		
18	Open the gate. The safety system trips. The IN2 and OUT status indicators turn OFF. The IN1 status indicator remains ON. The motor coasts to a stop. Do not close the gate.		
19	Press and release the Reset button. The IN2 and OUT status indicators of the GSR DI remains OFF. The motor does not start.		
20	Close the gate. The IN2 status indicator turns ON. The OUT status indicator blinks. The motor does not start.		
21	Press and release the Reset button. The OUT status indicator of the GSR DI turns steady (ON). The motor does not start.		
22	Press the Start button to start the motor.		

**Door Monitoring Safety Function Verification and Validation Checklist (continued)****Abnormal Operation Validation - The safety relay system properly responds to all foreseeable faults with corresponding diagnostics.****E-stop Input Tests – Guardmaster Dual-input Safety Relay (GSR DI)**

<b>Test Step</b>	<b>Verification and Validation</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
1	While the motor is running, remove the E-stop input wire at terminal S12 of the GSR DI. The GSR DI immediately trips, de-energizing the safety contactors and the motor coasts to a stop. The IN1 and OUT status indicators turn OFF.		
2	Reconnect the wire to S12. The GSR DI does not respond. Press and release the Reset button. The GSR DI does not respond.		
	Cycle the E-stop button. The IN1 status indicator is ON and the OUT status indicator is blinking. Press and release the Reset button. The OUT status indicator is steady (ON).		
3	Press the Start button. The motor starts to run. This step is skipped in the following tests.		
4	While the motor is running, jump the E-stop input wire at terminal S11 to terminal S12 of the GSR DI. The GSR DI does not trip.		
5	Press the E-stop button. The GSR DI immediately trips and the IN1 and OUT status indicators turn OFF.		
6	Release the E-stop button. Press and release the Reset button. The GSR DI does not respond.		
7	Remove the jumper from S11 to S12. Press and release the E-stop. The IN1 status indicator is ON and the OUT status indicator is blinking. Press and release the Reset button. The OUT status indicator is steady (ON).		
8	Repeat steps 1...7 to test E-stop channel 2. Use S21 in place of S11 and S22 in place of S12.		
11	Briefly short the E-stop input wire at terminal S12 of the GSR DI to 24V DC. The GSR DI immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
12	Press and release the Reset button. The GSR DI does not respond.		
13	Cycle power to the GSR DI. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		



**Door Monitoring Safety Function Verification and Validation Checklist (continued)****Abnormal Operation Validation - The safety relay system properly responds to all foreseeable faults with corresponding diagnostics. (continued)****E-stop Input Tests – GSR DI (continued)**

<b>Test Step</b>	<b>Verification and Validation</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
14	Briefly short the E-stop input wire at terminal S12 of the GSR DI to 0V DC. The GSR DI immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
15	Press and release the Reset button. The GSR DI does not respond.		
16	Cycle power to the GSR DI. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
17	Repeat steps 11...16 to test E-stop input channel 2. Use S22 in place of S12.		
21	Briefly short the E-stop terminal S12 to terminal S22 of the GSR DI. The GSR DI immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
22	Press and release the Reset button. The GSR DI does NOT respond.		
23	Cycle power to the GSR DI. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		

**Door Monitoring Safety Function Verification and Validation Checklist (continued)**

<b>Trojan Input Tests - GSR DI</b>			
<b>Test Step</b>	<b>Verification and Validation</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
1	Remove the Trojan input wire at terminal S32 of the GSR DI. The GSR DI immediately trips de-energizing the safety contactors and the motor coasts to a stop. The IN2 and OUT status indicators turn OFF.		
2	Reconnect the wire to S32. The GSR DI does not respond. Press and release the Reset button. The GSR DI does not respond.		
3	Open and close the gate. The PWR/Fault, IN1, and IN2 status indicators are green (ON). The OUT status indicator is blinking green. Press and release the Reset button. The OUT status indicator turns steady green.		
4	Jump the Trojan input wire at terminal S11 to terminal S32 of the GSR DI. The GSR DI does not respond.		
5	Open the gate. The GSR DI immediately trips. The IN2 and OUT status indicators turn OFF.		
6	Close the gate. Press and release the Reset button. The GSR DI does not respond.		
7	Remove the jumper from S11 to S32. Open and close the gate. The IN2 status indicator is ON and the OUT status indicator is blinking. Press and release the Reset button. The OUT status indicator is steady (ON).		
8	Repeat steps 1...7 to test Trojan channel 2. Use S21 in place of S11 and S42 in place of S32.		
11	Briefly short the Trojan input wire at terminal S32 of the GSR DI to 24V DC. The GSR DI immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
12	Press and release the Reset button. The safety system does not respond.		
13	Cycle power to the GSR DI. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turn steady green.		
14	Briefly short the Trojan input wire at terminal S32 of the GSR DI to 0V DC. The GSR DI immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
15	Press and release the Reset button. The GSR DI does not respond.		

**Door Monitoring Safety Function Verification and Validation Checklist (continued)****Trojan Input Tests - GSR DI (continued)**

<b>Test Step</b>	<b>Verification and Validation</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
16	Cycle power to the GSR DI. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		
17	Repeat steps 1...9 to test Trojan input channel 2. Use S42 in place of S32.		
21	Briefly short the Trojan input terminal S32 to terminal S42 of the GSR DI. The GSR DI immediately trips. The PWR/Fault status indicator is steady red. All other status indicators are OFF.		
22	Press and release the Reset button. The GSR DI does not respond.		
23	Cycle power to the GSR DI. Confirm that the PWR/Fault, IN1, and IN2 status indicators are green. Confirm that the OUT status indicator blinks green. Press and release the Reset button. The OUT status indicator turns steady green.		

**Logic Switch Setting Tests - GSR DI**

<b>Test Step</b>	<b>Validation</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
1	While the system is running, turn the logic rotary switch on the safety relay from the proper 2 to 4. The motor keeps running. The PWR/Fault status indicator blinks red/green twice then remains green and repeats the pattern.		
2	Press and release the E-stop button. The system trips and the motor stops. The PWR/Fault status indicator blinks red/green twice then remains green and repeats the pattern. The OUT status indicator blinks, requesting a Reset.		
3	Press and release the Reset button. The OUT status indicator turns steady green indicating that the GSR DI has reset. The PWR/Fault status indicator continues to blink red/green twice then remains green and repeats the pattern.		
4	Press the Start button. The motor starts and the PWR/Fault status indicator continues to blink red/green twice then remains green and repeats the pattern.		
5	Set the rotary switch back to 2. After a moment, the PWR/Fault status indicator turns steady green.		

**Door Monitoring Safety Function Verification and Validation Checklist (continued)****Safety Output - PowerFlex 525 Drive Tests**

<b>Test Step</b>	<b>Verification and Validation</b>	<b>Pass/Fail</b>	<b>Changes/Modifications</b>
1	Power up the safety system. Confirm that the E-stop is released and the gate is closed. Press and release the Reset button to start/reset the GSR DI. Press the Start button. The motor starts.		
2	While the motor is running, remove the wire from terminal 14 of the GSR DI. The GSR DI does not trip. The drive trips and the motor stops.		
3	Reconnect the wire to terminal 14. The drive does not start. Press the Start button. The drive does not start.		
4	Power down the drive, then power it back up. Once the drive is fully up, press the Start button. The motor starts.		
5	While the motor is running, remove the wire from terminal 24 of the GSR DI. The GSR DI does not trip. The drive trips and the motor stops.		
6	Reconnect the wire to terminal 24. The drive does not start. Press the Start button. The drive does not start.		
7	Power down the drive, then power it back up. Once the drive is fully up, press the Start button. The motor starts.		

## Additional Resources

These publications contain additional information concerning related products from Rockwell Automation.

Resource	Description
Guardmaster Safety Relay DI Installation Instructions, publication <a href="#">440R-IN037</a>	Provides guidance on installing, commissioning, operating, and maintaining 440R-D22R2 Safety Relays.
Guardmaster Safety Relay DI/DIS Quick Start Guide, publication <a href="#">440R-TG002</a>	Provides guidance on Trouble Shooting 440R-D22R2 Safety Relay installations.
Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>	Provides general guidelines for installing an industrial automation system.
PowerFlex 525 Adjustable Frequency AC Drive User Manual, publication <a href="#">520-UM001</a>	Provides guidance on installing, starting up, and troubleshooting the PowerFlex 520-Series Adjustable Frequency AC Drive.
Global Short Circuit Current Ratings Product Profile, publication <a href="#">SCCR-PP001</a>	Provides the SCCR selection Tables for component drive circuits.
PowerFlex 525-Series AC Drive Specifications, publication <a href="#">520-TD001</a>	Provides information on the PowerFlex 525-Series AC Drives.
Trojan 5 and 6 Installation Instructions, publication <a href="#">440K-IN002</a>	Provides guidance on installing, starting up, and troubleshooting the Trojan 5 and 6 switches.
Safety Products Catalog, publication <a href="#">S117-CA001A</a>	Provides overview of products, product specifications, and application examples.

You can view or download publications at <http://www.rockwellautomation.com/literature>. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

For more information on  
Safety Function Capabilities, visit:  
[discover.rockwellautomation.com/safety](http://discover.rockwellautomation.com/safety)

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